

MARSHALL SPACE FLIGHT CENTER

NASA FACULTY FELLOWSHIP PROGRAM (NFFP)

RESEARCH/TASKS AVAILABLE FOR SUMMER 2004

Science Directorate

TITLE OF RESEARCH/TASK

Synchronized pulsed gas lasers for in-space fabrication

BRIEF DESCRIPTION OF RESEARCH/TASK

Construct solar-powered pulsed gas lasers, synchronized to achieve output powers sufficient for laser ablation of materials.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

Materials Science, Optics, Chemistry, Physics, Spectroscopy

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Dr. David D. Smith	SD46	256-544-7778	david.d.smith@nasa.gov

DEPARTMENT

Microgravity Sciences and Applications Department

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TITLE OF RESEARCH/TASK

Preliminary Evaluation of Martian Simulant Soils for Element Extraction

BRIEF DESCRIPTION OF RESEARCH/TASK

Planetary exploration will require systems dedicated to propellant production, life support, habitat construction and repair, and energy production. These systems all depend critically on in-situ resource utilization (ISRU) to use raw materials and generate processed materials. ISRU may involve processing both in space and on planetary surfaces. Successful planning for these missions requires detailed knowledge of processing and extraction techniques utilizing soil, rock, and atmospheric source materials. This in turn requires an understanding of the chemistry, physics, and mineralogy of soils, phase equilibria of mineral, melt and gaseous phases, and the environmental conditions on the planetary body. We are seeking an inquisitive person who will bring original ideas to our approach during the start up phases of this program. We anticipate that the study will use theoretical and experimental methods, including exploratory melting and reduction experiments to investigate the use of JSC Mars-1 Martian soil for elemental extraction. This work will support the strategic goals of the Physical Sciences Research Division of NASA's Office of Biological and Physical Research.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

Background in Physics, Geology and Materials Science

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DEPARTMENT

Microgravity Science and Applications Department

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TITLE OF RESEARCH/TASK

Biochemical microfluidic process development

BRIEF DESCRIPTION OF RESEARCH/TASK

The Lab-On-a-Chip Application Development (LOCAD) project within the Microgravity Science and Application Department at MSFC has research opportunities for SFFP participants in the area of analytical biochemical research. The LOCAD project has very unique microfluidic flow control facilities on-site that will be used to conduct research work in microfluidic mixing, particle/fluid sorting, species separation and on-chip bio-chemical process development in nanoliter-scale flows for applications such as environmental monitoring, planetary protection, crew health monitoring, and life detection.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK**MSFC SPONSOR**

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MSAD, SD40

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TITLE OF RESEARCH/TASK

Effects of High-LET Low-Dose Irradiation on Shielding Material Properties

BRIEF DESCRIPTION OF RESEARCH/TASK

Our program is in need of a physicist/material scientist-engineer to evaluate, quantify, and suggest future directions on the potential effects of high-LET, low-dose irradiation on the physical properties of shielding materials. A number of these shielding candidates are currently being developed at Marshall. Recent high-energy beam exposure tests of the shielding-material samples at NSRL (NASA Space Radiation Lab.) at Brookhaven National Lab. Facilities seem to suggest that some changes in the optical properties of sensors embedded in the samples have occurred. Because of the typically low-dose exposure, radiation effects on such properties are minimal. Hence, the recent data must be evaluated and understood.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

Physics (condensed matter/atomic); Material Science/Engineering (radiation); Chemistry (physical)

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Biol. and Phys. Science for Exploration Team/SD-46

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TITLE OF RESEARCH/TASK

Fluid Behavior of Molten Feedstock Material During Solid Freeform Fabrication

BRIEF DESCRIPTION OF RESEARCH/TASK

Solid Freeform Fabrication is a method of Rapid Prototyping that is potentially important for extended missions. Rapid prototyping is widely used in making prototypes directly from electronic CAD data files and is used to produce limited quantities during product development. This method has potential for fabricating replacement parts or consumables on extended NASA missions without having to have a large inventory. There is a need to develop the science associated with the deposition process during solid freeform processing taking into effect the rheological properties of the molten feed stock material, effects of surface tension, and expected differences in sample behavior in low gravity.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

A polymer chemist/engineer with rheological experience is desired.

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DEPARTMENT

Microgravity Science and Applications Department – SD40

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TITLE OF RESEARCH/TASK

Study of Properties and Failure Modes of Foam and Other Low-Density Composites

BRIEF DESCRIPTION OF RESEARCH/TASK

To establish a better understanding of the behavior and properties of low-density thermal protection system (TPS) materials (e.g., the Shuttle External Tank foam) by using novel x-ray imaging techniques, we seek a scientist who can interact with NASA researchers by working in

one of the following areas: (1) development of algorithms for phase retrieval (from phase contrast x-ray imaging data) and quantitative reconstruction of density in 3D; (2) relationship between cellular structure and physical properties of foamed polymers including designing and development of a loading cell for in situ x-ray imaging measurements.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

Computational Science (or Physics), Foam Science (or Engineering), Chemical Engineering

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DEPARTMENT

Microgravity Science and Applications

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TITLE OF RESEARCH/TASK

Inductively Coupled Plasma Ionizer

BRIEF DESCRIPTION OF RESEARCH/TASK

Assemble and test a radio frequency coupled ionizer of small size and power to produce a plasma discharge in low pressure argon. This device will ionize laser ablated species associated with lunar and Martian soil simulants, for subsequent mass analyses.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

Knowledge of radio frequency circuits and applications.

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Microgravity Science and Applications Department - SD40

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TITLE OF RESEARCH/TASK

Detached Bridgman crystal growth

BRIEF DESCRIPTION OF RESEARCH/TASK

Investigation of the process of detached growth of Germanium. Experimental and theoretical work on the effect of different experimental conditions and materials properties on the shape of the meniscus and related detachment process.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

Materials science, crystal growth

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DEPARTMENT

Microgravity Science and Applications

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TITLE OF RESEARCH/TASK

Membrane Protein Studies

BRIEF DESCRIPTION OF RESEARCH/TASK

The task will involve the preparation/purification of membrane proteins, preferably those which may be relevant to bone or muscle formation or loss, such as occurs in a microgravity environment. Following purification, we will attempt to crystallize these protein using novel methods currently under development at MSFC.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

Biochemistry, biophysics, chemistry and/or biology.

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SD40 / SD46

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TITLE OF RESEARCH/TASK

Magnetic Materials and their Properties

BRIEF DESCRIPTION OF RESEARCH/TASK

Characterization of magnetic properties of semi-conductors, magnetic domain analysis, Curie temperature distribution, etc. Characterization based on Vibrating Sample Magnetometry and ferrofluid based domain analysis.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

Materials science, magnetics

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DEPARTMENT

Microgravity Science and Applications Department – SD40

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TITLE OF RESEARCH/TASK

Optical Diagnostics for Advanced Materials for In-space Manufacturing and Repair and Fluids studies.

BRIEF DESCRIPTION OF RESEARCH/TASK

Development of optical diagnostic techniques such as Interferometry and Schlieren Techniques to be applied to experiments with concentration and temperature gradients. Phase stepping and shearing interferometry and extracting quantitative information from such measurements.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

Optics or mechanical engineering

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Microgravity Science and Applications Department – SD40

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TITLE OF RESEARCH/TASK

Modeling of Concepts for Bubble-free Fluid Containment in Microgravity

BRIEF DESCRIPTION OF RESEARCH/TASK

Modeling of the behavior of fluids contained in structures incorporating meshes of various sizes and materials. Research will include investigation of the relationship between fluid characteristics such as surface tension, and mesh characteristics including mesh opening and container geometry on the filling efficiency of these containers in microgravity. This work will support preparations for planned reduced gravity experiments on the KC-135 aircraft.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

Fluid dynamics

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TITLE OF RESEARCH/TASK:

Studies on cryogenic preservation of macromolecular crystals.

BRIEF DESCRIPTION OF RESEARCH/TASK:

The research will cover the application of thermal imaging, visual imaging, X-ray diffraction and biophysical techniques to enhance and optimize the cryocooling process used in X-ray structural biology. The research is conducted at two levels, an experimental level and theoretical modeling of the experimental results. Some experience in macromolecular crystallography, thermal modeling or infrared imaging would be useful.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK:

Physics/Chemistry or biology.

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TITLE OF RESEARCH/TASK

Structural Transformation in I-III-VI Melts

BRIEF DESCRIPTION OF RESEARCH/TASK

To support the newly awarded NASA Code U NRA project, the research will conduct quantitative measurements of the relevant thermophysical properties of the III-VI and I-III-VI melts (including In-Se, Ga-Se, In-Te, Ga-Te, Ag-Ga-Se, and Ag-Ga-Te), such as viscosity, electrical conductivity, thermal diffusivity and density as well as the relaxation characteristics of these properties to advance the understanding of the structural transformation and the relaxation phenomena in the melts.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

Mechanical Engineering, Materials Science

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DEPARTMENT

Microgravity Science and Applications Department

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TITLE OF RESEARCH/TASK

Evolution of Local Microstructures

BRIEF DESCRIPTION OF RESEARCH/TASK

A primary objective of a funded Code U sponsored Materials Science proposal is to study the details of evolving microstructures rigorously through a study of "island" formation in heteroepitaxial film/substrate systems. Such systems are of direct relevance to so-called *mixed-dimensional* coarsening and to the study of heterostructures grown by thin-film techniques. The research would involve the development and implementation of apparatus to perform holographic studies of coarsening on two-dimensional substrates. Activities would include the development of arrays of nucleation sites and surface testing.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

Materials Science, Chemistry, Chemical Engineering and Physics

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DEPARTMENT

Microgravity Sciences and Applications Department

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TITLE OF RESEARCH/TASK

Studies of proteins relevant to bone formation.

BRIEF DESCRIPTION OF RESEARCH/TASK

We are studying the protein RUNX2, which is considered the "master switch for bone formation", indicating that it has a pivotal role in regulating the formation and activation of osteoblasts (bone forming cells). For this study, we need to prepare various parts and lengths of the RUNX2 protein by means of molecular biology. We will use this protein and its mutants for structural biology studies. We have an opportunity for a scientist with molecular biology and/or protein purification and characterization experience to participate in our research.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

Molecular biology or biochemistry.

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Dr. Mark J. van der Woerd	SD46	256-544-3343	Mark.vanderWoerd@msfc.nasa.gov

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DEPARTMENT

Microgravity Science and Applications Department – SD40

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TITLE OF RESEARCH/TASK

Space Plasma Physics Research

BRIEF DESCRIPTION OF RESEARCH/TASK

Our research group studies the physics of the terrestrial magnetosphere through theory, data analysis, and experimentation. Theory involves both analytical development and numerical equation solving. Data analysis is focused on low energy particles and ultraviolet measurements from the POLAR, IMAGE, Interball Tail, and Cluster spacecraft. Experimental efforts are currently focused on the development of new low energy electron and ion instrumentation. Plasma and dusty plasma physical properties and processes are being studied. Research problems related to physics and computer science are available. The group is also in need of support in the area of communicating current research to the public and students through the World Wide Web.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

Physics (space plasma and dusty plasma); Computer Science (numerical analysis and image inversion); Internet-based science communication and visualization.

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Mike Chandler
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Paul Craven
George Khazanov
Jim Spann
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DEPARTMENT

Space Science Department, Space Plasma Physics Group/SD50

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TITLE OF RESEARCH/TASK

Application of AIRS Retrievals to Severe Weather

BRIEF DESCRIPTION OF RESEARCH/TASK

In 2002, NASA launched the Atmospheric Infrared Sounder (AIRS) instrument on the AQUA satellite to monitor the temperature and moisture structure of the atmosphere on a global basis. These measurements can also be used to retrieve high vertical resolution profiles of temperature and moisture at mesoscale spatial resolutions to assist in diagnosing regions of convective instability favorable for thunderstorm and severe weather development. This research will evaluate and document this potential capability through case study analysis and evaluation of a number of severe storm events.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

Meteorology or atmospheric science, remote sensing of atmosphere by satellites

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Mr. Ron Suggs	SD60	256-961-7895	ron.suggs@msfc.nasa.gov

DEPARTMENT

Earth Science Department / SD60

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TITLE OF RESEARCH/TASK:

Comparison of Florida lightning flash charges as estimated by NLDN data and NASA KSC field mill data

BRIEF DESCRIPTION OF RESEARCH/TASK

Use peak current and multiplicity data derived from the National Lightning Detection Network (NLDN) in conjunction with established lightning current waveform models to estimate the charges deposited in Florida lightning flashes. Compare the results with charge estimates obtained via conventional inversion of Kennedy Space Center (KSC) Advanced Ground Based Field Mill (AGBFM) data. Determine the feasibility of using NLDN data to estimate flash charge elsewhere in the US. [Note: flash charge is an important variable since it is related to flash energy and hence global Lightning NO_x production.]

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

Mathematical Physics, Lightning Physics

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DEPARTMENT

Earth Science-SD60

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TITLE OF RESEARCH/TASK

The Role of the Ocean in Tropical Precipitation Variability on Interannual Time Scales

BRIEF DESCRIPTION OF RESEARCH/TASK

A major component of the research performed by the Climate Dynamics and Modeling Group of SD60 involves analyzing and modeling tropical precipitation and its variability, especially on interannual timescales. The ocean, through air-sea interactions, plays a fundamental role in tropical precipitation. Our group has made significant contributions to understanding interannual variations in the tropical water balance (e.g. El Nino) despite having insufficient expertise in physical oceanography and its relation to climate. Our work relates directly to the ESE theme: "How is the global Earth System changing (Variability), in particular, how are global precipitation, evaporation, and the cycling of water changing?" Developing research ties to a physical oceanographer would also leverage NASA NSIPP and GWEC funding that we already have for research in climate variability. Finally, access to this expertise would also be part of ongoing collaborative efforts between MSFC/SD60 and the Climate and Carbon Research Center of Oak Ridge National Laboratory (ORNL/CCR).

Through the NFFP we would hope to bring in a faculty researcher who could help support us by providing expertise in oceanography and air-sea interactions during the summer of 2004. Specific research tasks that this individual would undertake (or assist with) include:

- Examining air-sea interactions within the NASA Seasonal to Interannual Prediction Program (NSIPP) and National Center for Atmospheric Research Community Climate System Model (NCAR/CCSM) climate models. These global models contain ocean, atmospheric, and land surface components. Atmospheric wind stress on the tropical Pacific ocean surface and feedbacks from the ocean to the atmosphere in terms of altered energy fluxes are key to predicting El Nino / La Nina events. Both of these models are state of the art codes, but seem to have weak and too regular El Nino events. One task we need addressed is to compile complete model heat and energy budgets at the surface over the tropical Pacific oceans. This task would allow us to compare the model results to retrievals of radiative fluxes, turbulent heat and momentum fluxes and to determine model inadequacies. Last year Dr. Stephens began analyzing heat budget components from observations and models for comparison. Continuing this research she began would make a valuable contribution to the MSFC research efforts currently funded by HQ Code YS.
- A second and related task would involve looking at much longer time scales (several decades of model integration) and examining the storage of heat in the ocean. NSSTC scientists have shown that current surface temperature trends and those from microwave satellites have different trends. How clouds in the model atmosphere affect ocean heat storage may be a key factor in understanding these trends. This task would enable NSSTC and SD60 to address questions highlighted in the evolving National Climate Change Science Program. Last year Dr. Stephens began examining some multi-decadal time series from model integrations. We have just been given access to new model simulations made under the auspices of the Department of Energy and would like her to examine the low frequency behavior of these model projections of historical and 21st century climate.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

Applied Mathematics, Oceanography, Climate Modeling

MSFC SPONSOR

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DEPARTMENT
Earth Science (SD60)

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TITLE OF RESEARCH/TASK
Ablative Laser Propulsion

BRIEF DESCRIPTION OF RESEARCH/TASK
Studies have shown that ablative laser propulsion can produce very high ISP and has potential for use in many propulsive programs. We need a researcher to evaluate the effects of production of relatively low velocity neutrals in the plasma plume produced in the ablation event.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

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James Carter	SD72	256-544-3469	james@taurus.msfc.nasa.gov

DEPARTMENT
Space Optics Manufacturing Technology Center

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TITLE OF RESEARCH/TASK
Development of Three-Dimensional Photonic Bandgap Materials

BRIEF DESCRIPTION OF RESEARCH/TASK
The research task emphasizes wave and physical optics; specifically three-dimensional photonic bandgap materials (PBGM's). The method chosen to fabricate these materials involves the preparation of a template of periodic structure, infiltration of high refractive index or other materials of interest, and removal of the initial template leaving the infiltrated material. Template formation involves first synthesis of monodisperse silica spheres of various diameters followed by the self-assembly or electrophoretic deposition into close packed Face Centered Cubic structure. Infiltration of silicon, a high refractive index material, is planned to be performed through sputtering. The final step is to etch the silica spheres away using an acid. Infiltration of monomeric diacetylene is also being tried to form a conjugated polymer PBGM. PBGM has a number of applications that will aid NASA research activities. Several examples of technologies that stand to benefit from PBGM include omnidirectional reflectors, zero threshold microcavity lasers, integrated circuits, sub picosecond optical switches, and optical transistors.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

Materials Science, Chemistry, Optics

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DEPARTMENT

SD70 – Optics Department

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